

HEMMING APPARATUS AND METHOD

This application claims the benefit of and hereby expressly incorporates by reference U.S. Provisional Application Serial No. 60/141,434, filed on June 29, 1999.

Background of the Invention

5 Field of the Invention

The present invention relates to the hemming arts. More particularly, the present invention relates to improvements in a hemming apparatus and an improved method for hemming sheet metal or like material together. The
10 present invention finds particular application in the automotive field and will be described with particular reference thereto. However, it is to be appreciated that the present invention is also amenable to other like applications.

15 Discussion of the Art

In the automotive field it is often desirable to join two pieces of sheet metal together in a hemming operation to form a door, hood, trunk deck, or other such component. Generally, a unitary outer skin of sheet metal
20 is hemmed to a second inner reinforcing panel of sheet metal. Hemming involves bending and compressing a generally upturned or perpendicular flange located along each edge of the outer sheet over an adjacent edge of the inner panel. It is important that the hemming results in
25 a firm, vise-like grip of the flanges of the inner panel between the outer panel and its marginal flanges and that

the shape and dimensions of the overall assembly are held within prescribed tolerances.

See 117
In the prior art, such hemming has often been accomplished in two separate stages often using two sets of dies mounted in two successive presses. The inner reinforcing panel is nested within the unitary outer panel which is fixtured on an anvil die on a base of a prehemming machine. Upon fixturing the assembly, a tool of the machine, commonly referred to as a hemming steel, engages and bends an edge of the outer panel to an acute included angle with respect to the outer panel. Prehemming is sometimes referred to as "fortyfive-ing" because the angle of the flange becomes about forty-five degrees with respect to the general plane of the outer panel. After prehemming all edges to be joined, both panels are released, transferred to, and fixtured in a second hemming machine where a second steel completely bends the prehemmed edge of the outer panel over the peripheral edge of the reinforcing panel to secure and attach the panels together as a unitary structural member for assembly on a vehicle. This second stage is often referred to as full-hemming.

An obvious disadvantage of the two-stage, two-machine system is the need for two machines which require a significant amount of floor space as well as time and labor resources required for moving the assembly out of one press and into the second press. Because of these disadvantages, the two-stage, two-press system was improved upon and eventually evolved into a single station, two press system where prehemming and full-hemming occur without the need for re-fixturing the assembly between stages. Typically, a plurality of both prehemming and final hemming machines were respectively grouped around the periphery of a panel to perform all prehemming and full-

hemming operations for one assembly either sequentially or substantially simultaneously.

After further improvements, hemming machines were designed to perform both the prehem and final hem operation
5 in a single station, single machine system. Hemming machines of this type vary in the kind of mechanism used and the manner of carrying out the hemming operations.

One group includes machines having linkage driven
10 steels, machines having one rotary steel driven by another linear driven steel, and machines having one steel telescopingly hem from within the prehemming steel. Representative of this group are the following patents: U.S. Patent No. 1,693,643 to D'Ardenne, U.S. Patent No. 5,404,742 to Wilson et al, and U.S. Patent No. 3,903,934 to
15 Vizy.

Another group includes machines having steels
20 that traverse generally linearly in one or two directions. hemming machines of this type, such as U.S. Patent No. 3,143,095 to Tribe, may have a prehemming steel traversing across the general plane of the outer skin and a full-hemming steel traveling perpendicular to the plane of the outer skin. The obvious disadvantage of this type of machine is that it requires two steels or dies, two
25 directions of travel, extra cycle time for two operations, and a substantial amount of space around the assembly which prevents the hemming of internal edges. Alternatively, machines, such as U.S. Patent No. 5,315,855 to Jackson, use a single steel traversing in only the plane of the outer skin have been disclosed but still require a substantial
30 amount of space preventing internal hemming and often result in a hem that is not firm, out of tolerance, and of low visual quality. Finally, there are machines, such as U.S. Patent No. 1,961,582 to Eksergian, that travel only

perpendicular to the general plane of the outer skin but still require substantial space around the assembly, two steels, and do not create a quality hem.

Therefore, it is desirable to provide an improved
5 apparatus and method for hemming sheet material together. The present invention contemplates such an invention that overcomes many of the problems of the prior art and others.

Brief Summary of the Invention

2 In accordance with the present invention, an
10 improved apparatus and method for prehemming and hemming is provided for minimizing the above-referenced and other disadvantages of the prior art, and in particular, for folding an edge portion of a curved arcuate panel to create a hem in a single cycle of operation with a single hemming
15 swing steel pressed only in the vertical direction.

20 In accordance with one aspect of the present invention, a hemming apparatus for hemming an outer skin and inner panel together is provided. The apparatus includes an anvil for supporting an associated assembly.
25 The assembly comprising the outer skin and the inner panel. The apparatus additionally includes an upper body and a steel mounted to the upper body. The steel is adapted for movement between first and second operative positions. Furthermore, the steel has a first angled surface for
30 prehemming the assembly when the steel is in the first operative position and a second angled surface for full-hemming the assembly when the steel is in the second operative position.

35 In accordance with another aspect of the present invention, a method for hemming an outer skin and inner panel together is provided. It includes placing an

assembly on a supporting surface of an anvil. The assembly comprising an inner panel positioned on an outer skin where the inner panel has a peripheral edge and the outer skin has a peripheral flange. It next includes moving a hemming steel, while in a first operative position, in a first direction into the peripheral flange of the outer skin so that an angled prehemming surface of the steel deforms the flange toward the inner panel thereby prehemming the assembly. The hemming steel is further moved in the first direction moving the hemming steel into a second operative position. Meanwhile, the steel moves into the deformed peripheral flange so that a hemming surface of the steel engages the deformed flange and moves it into close contact with the inner panel thereby full-hemming the assembly. Finally, the steel is moved away from the hemmed assembly and removing the finished assembly from the supporting surface.

Ins 97 One advantage of the present invention is the provision of a hemming apparatus that requires only one steel reducing the construction costs of the machine and the maintenance costs of the steel.

Ins 98 Another advantage of the present invention is the provision of a hemming apparatus that substantially reduces the risk of the die "smashing" because the machine will only use one steel to contact the peripheral edge of the assembly.

Another advantage of the present invention is the provision of a hemming apparatus that lacks many complex and moving components.

Another advantage of the present invention is the provision of a hemming apparatus that uses only vertical press motion which prevents compression of the outer, and more visual, skin. Preventing such compression eliminates

or reduces unsightly buckling or waves caused by overruns on the inner skin.

Another advantage of the present invention is the provision of a hemming apparatus that only requires a
5 vertical, mechanical press for operation.

Another advantage of the present invention is the provision of a hemming apparatus that requires only one stroke of a mechanical press to produce a complete hem.

Another advantage of the present invention is the
10 provision of a hemming apparatus that may be used in places such as window openings, gas cap openings, and the like.

Another advantage of the present invention is the provision of a hemming apparatus that substantially reduces the number of weld spots typically required for an entire
15 assembly.

Still further advantages and benefits of the present invention will become apparent to those of ordinary skill in the art upon reading and understanding the following detailed description.

20 Brief Description of the Drawings

The structure, operation and advantages of the presently preferred embodiment of this invention will become further apparent upon consideration of the following description, taken in conjunction with the accompanying
25 drawings. Of course, the drawings are only for purposes of illustrating preferred embodiments and are not to be construed as limiting the invention.

FIG. 1a is a cross-sectional view of two sheets prior to prehemming and full-hemming in accordance with
30 aspects of the present invention;

FIG. 1b is a cross-sectional view of the two sheets depicted in FIG. 1a after prehemming and before

full-hemming in accordance with aspects of the present invention;

FIG. 1c is a cross-sectional view of the two sheets depicted in FIG. 1a after prehemming and full-hemming in accordance with aspects of the present invention;

FIG. 2 is a diagrammatic view showing a preferred embodiment of a hemming apparatus in accordance with aspects of the present invention;

FIG. 3 is a diagrammatic side view of a prior art two-steel, two-directional hemming apparatus and its related compression forces;

FIG. 4 is a diagrammatic view of the hemming apparatus shown in FIG. 2 and its related compression forces in accordance with aspects of the present invention;

FIG. 5 is a diagrammatic view of an alternate embodiment of a steel in accordance with aspects of the present invention;

FIG. 6a is a diagrammatic view showing an alternate preferred embodiment of a hemming apparatus in accordance with aspects of the present invention;

FIG. 6b is a diagrammatic view of the hemming apparatus shown in FIG. 6a showing the steel in a first position prehemming an assembly; and

FIG. 6c is a diagrammatic view of the hemming apparatus shown in FIG. 6a showing the steel in a second position full-hemming the assembly.

Detailed Description of the Invention

Referring now to the drawings wherein like reference characters represent like elements, the showings

are for purposes of illustrating preferred embodiments of the invention only and not for purposes of limiting the same. The improved hemming apparatus and method described in the description below accurately and speedily carries
5 out an entire prehemming and clinching/full-hemming operation in one cycle and supplies firmly clinched flanges without affecting the dimensional accuracy or the visual appearance of the finished product.

With reference to FIGS. 1a-1c, an assembly is
10 generally indicated by reference numeral 10. The assembly 10 includes two elements of pressed sheet metal or other suitable material respectively constituting the unitary outer skin 12 and the inner reinforcing panel 14 of a motor vehicle assembly. The assembly 10 may be, without
15 limitation, a motor vehicle door, hood, trunk deck or other component. The assembly 10 rests on a fixed supporting structure or anvil 16. The anvil 16 has a horizontal supporting surface 18 for positioning and supporting the outer skin 12 and the inner panel 14.

20 FIGS. 1a-1c depict the sequential movement and resulting position of the assembly 10 during a hemming operation. With specific reference to FIG. 1a, the outer skin 12 and the inner panel 14 are shown at rest prior to the hemming operation. The underlying outer skin 12 has a
25 peripheral flange 12a arranged substantially at ninety degrees with respect to the anvil supporting surface 18 and is offset slightly from distal end of the peripheral edge 14a of the overlying inner panel 14 as is well known.

With specific reference to FIG. 1b, the outer
30 skin 12 and the inner panel 14 are shown after the first step or prehemming step of the hemming operation. In this step, the peripheral flange 12a of the outer skin 12 is

bent forty-five degrees relative to its starting position in the direction of the inner panel 14.

With specific reference to FIG. 1c, the outer skin 12 and the inner panel 14 are shown after the clinching or full-hemming step. In this step, the peripheral flange 12a of the outer skin 12 is bent further and now is arranged at about ninety degrees relative to its initial position. The peripheral flange 12a is superimposed and pressed against the peripheral edge 14a creating a joint between the outer skin 12 and the inner panel 14. Many such joints may exist on a single assembly 10 and are generally located about the periphery edges of the outer skin 12 and the inner panel 14. Joints may even be located at interior locations on the assembly 10 such as a window or gas cap recess.

With reference to FIG. 2, a hemming apparatus 15 includes a lower body or anvil 20 having a major supporting surface 22 for supporting the unitary outer skin 12 and the inner reinforcing panel 14. The inner panel 14 is positioned on the outer skin 12 with its edge 14a slightly offset from the peripheral flange 12a. The flange 12a is arranged substantially at ninety degrees with respect to the anvil supporting surface 22. The peripheral flange 12a on the outer skin 12 rests directly along one edge 24 of the anvil 20. The same edge 24 of the anvil 20 is adjacent to a sloping side 26, angled at forty-five degrees in the preferred embodiment of the invention.

ins 113
The hemming apparatus 15 additionally includes an upper body 27 as either a connected or separate component. The upper body 27 is mounted to a vertical press (not shown) as is well known. The upper body 27 holds the swing

tool or steel 28 formed in accordance with the present invention by means of a screw 30 or the like. Steel 28 is constructed of a suitable material with an appropriate hardness as is well known. The steel 28 has a round or rounded upper surface 32 which nestles inside a curved recess 34 of the upper body 27 such that the steel 28 may pivot outward from the upper body 27. An inner side 36 of the steel 28 rests against the keeper or extended portion 38 of the upper body 27. The outer or exposed side 40 is open and held in place by a spring 42 or other biasing means. The spring 42 is a blue medium duty die spring with a strength of 216 lbs. in the preferred embodiment. Of course, other suitable springs may be used.

2nd 14 7 The bottom surface of the steel 28 has two angled surfaces 50 and 52 defined at angles α and β , respectively. Angles α and β are relative to respective planes positioned parallel to the supporting surface 22. The prehemming angled surface 52, extends from the bottom open edge 44 of the steel 28 inward and upward to the approximate center 46 of the steel 28 at an angle α which is equal to that of the sloped side 26 of the anvil 20. Full-hemming angled surface 50 extends from the closed, bottom edge 48 of the steel 28 inward and downward at angle β to the approximate center 46 of the steel 28 meeting prehemming angled surface 52. The magnitude of angle β is such that when the steel 28 is forced vertically downward to its farthest position at which point the steel 28 is pivoting against the spring 42, angled surface 50 will rest parallel to the supporting surface 22 of the anvil 20.

2nd 15 30 In operation, the upper body 27 moves the steel 28 downward in a first operative position to contact the

peripheral flange 12a of the outer skin 12 and the sloping side 26 of the anvil 20. The upper body 27 is powered by a vertical press as is well known but other suitable driving means may be employed. When the steel 28 first
5 contacts the peripheral flange 12a, the flange 12a will bend inward toward the inner panel 14 until the prehemming angled surface 52 of the steel 28 contacts the sloping side 26 of the anvil 20. At this point, the steel is still in the first operative position and the bend in the peripheral
10 flange 12a is at angle α relative to the supporting surface 22 of the anvil 20. Thus, the prehemming of the peripheral flange 12a to the inner panel 14 is complete.

2nd 116
As the upper body 27 continues to move the steel 28 downward, i.e., toward the anvil support surface 22 and
15 a second operative position, the steel 28 is forced to pivot from the upper body 27 at the screw 30 against the force of the spring 42 owing to the prehemming surface 52 of the steel 28 slidably engaging the sloping side 26 of the anvil 20. The stiffness of the spring 42 is such that
20 steel 28 is generally secured against upper body 27, including during the prehemming operation, but gives appropriately when the steel 28 is forced to pivot against sloping side 26 of the anvil 20. The steel 28 will continue pivoting and moving downward until the full-
25 hemming angled surface 50 is substantially parallel to the supporting surface 22 of the anvil 20. At this point, the steel is in the second operative position and the peripheral flange 12a of the outer panel 12 and the inner panel 14 are completely hemmed.

30 In a preferred embodiment, the peripheral flange 12a will be arranged at about ninety degrees with respect

to its initial position so that it is superimposed and pressed against the peripheral edge 14a. The upper body 27 is then retracted upwards, moving the steel 28 upward and away from the hemmed outer skin 12 and inner panel 14. Of course, the spring 42 or other biasing means moves the steel 28 to its home or first operative position illustrated in FIG. 2. The outer skin 12 and inner panel 14 together form a complete hemmed assembly 10 which may now be removed from the anvil 20. Thus, the apparatus 15 will have only used one cycle of a vertical press to complete both the prehemming and full-hemming operations. Several steels 28 may be employed simultaneously and powered by a single vertical press. In such an arrangement, several hems are completed upon one stroke of the vertical press.

Ins 18
An important aspect of the present invention relates to its ability to substantially reduce undesirable compression forces typically exerted on the peripheral flange 12a in prior art hemming machines. Referring to FIG. 3, previously known devices often use a two-steel, two-stage process or other similar process to hem the outer skin 12 to the inner panel 14. Prehemming is accomplished when a horizontal steel 54 moves toward the assembly 10 and engages the peripheral flange 12a. Horizontal steel 54 continues and forces peripheral flange 12a to bend inward toward supporting surface 22 of the anvil 20 until horizontal steel surface 54a meets sloping surface 26.

Ins 19
Such a prehemming process is problematic because horizontal steel 54 begins forcing peripheral flange 12a to bend against the peripheral edge 14a. Thus, the skin 12 exerts a force on the panel 14 during the bending. Between the force of horizontal steel 54 and the immobile

resistance of anvil 20, this force causes either the outer skin 12 or the inner panel 14 to buckle producing an undesirable and rough finish. The vertical steel 56 completes the hem by full-hemming the peripheral flange 12a to the peripheral edge 14a but the unsightly buckle remains in the outer skin 12 or the inner panel 14.

mat20
Referring to FIG. 4, the present invention uses only vertical motion to complete the hemming operation in contrast to the prior art. The upper body 27 moves the steel 28 downward toward the peripheral flange 12a. When the tool 28 engages the peripheral flange 12a and begins bending the peripheral flange 12a inward and downward toward the supporting surface 22 of the anvil 20, the force C applied to the peripheral flange 12a is substantially downward. The buckling problem of the prior art is absent because the peripheral flange 12a is allowed to move out toward the slope side 26 of the anvil 20. Thus, the finished hem has a desirable finish without any unsightly buckles.

Optionally, an adhesive may be applied to the peripheral flange 12a of the outer skin 12 and to the peripheral edge 14a of the inner panel 14 prior to hemming to enhance the integrity of the hem. The adhesive seals and firms the hem and enhances some or all of the advantages of the present invention.

mat21
Alternately, with additional reference to FIG. 5, the steel 28 may include an indented radius 60 located along the intersecting edge between the full-hemming angled surface 50 and prehemming angled surface 52. The radius 60 provides clearance between the steel 28 and the assembly 10 during the movement of the steel 28 from the first operative position where prehemming occurs and the second

operative position where full-hemming occurs. Such clearance decreases the likelihood of the steel 28 damaging the peripheral flange 12a and edge 14a during the transition between the two positions.

5 With reference to FIGS. 6a-6c, a hemming apparatus 100 is shown according to an alternate preferred embodiment of the present invention. The apparatus 100 includes an anvil 20 having a major supporting surface 22 for supporting the unitary outer skin 12 and the inner
10 reinforcing panel 14. The supporting surface 22 is angled approximately twelve degrees relative to the vertical face 102 of the anvil 20. The outer skin 12 rests on the supporting surface 22 with the inner panel 14 positioned on
15 the outer skin 12. The outer skin 12 includes a peripheral flange 12a which extends away from and perpendicular to the supporting surface 22. The peripheral flange 12a is positioned at or near one edge 24 of the anvil 20. Adjacent the supporting surface 22 is a sloping side 26 which extends at a forty-five degree angle relative to the
20 supporting surface 22.

Ins 22
The hemming apparatus 100 includes an upper body 27. The upper body 27 is mounted to vertical press by means of a die shoe and a machine steel sub plate as is well known. The upper body 27 holds a steel 28 formed in
25 accordance with the present invention. The steel 28 has a rounded upper surface 32 which nestles inside a curved recess 34 of the upper body 27. An inner side 36 of the steel 28 rests against an extended portion 38 of the upper body 27.

Ins 23
30 The apparatus 100 additionally includes a spring housing 104 that encloses a medium or heavy duty die spring

42. The housing 104 is adapted to receive a preload spacer 106 at a distal end of the spring 42 and includes a spring cap 108 for forcing the spring 42 against the steel 28. The preload spacer 106 may vary and serves the purpose of
5 allowing for variable adjustment of the resistance of the spring 42. A plurality of roller bearings 110 are also provided and secured to the steel 28 by a connecting means 111. Roller bearings 110 engage a cam 114 mounted to the anvil 20 upon actuation and movement of the vertical press
10 toward the anvil 20 so that roller bearings 110 travel on the cam 114 and move the steel 28 into its second operative position. The steel 28 is shown in a first position prior to actuation and movement by the vertical press.

Int 24
15 Similar to the first preferred embodiment, the steel 28 has two angled surfaces, a prehemming surface 52 and a full-hemming surface 50. The respective angles of the surfaces 50 and 52 are calculated as described above. The prehemming surface 52 is at an angle approximately equal to that of the sloping side 26 and the hemming
20 surface 50 is at an angle adapted to provide a full hem upon pivotal movement of the steel 28.

Int 25
25 In operation, the upper body 27, powered by the vertical press, moves the steel 28 toward the peripheral flange 12a of the outer skin 12. The steel 28 is initially in a first or resting position, i.e., the steel 28 is urged
30 against the extended portion 38 by the spring 42. The steel 28 will contact and bend the peripheral flange 12a inward toward the inner panel 14 until the roller bearings 110 engage the cam 114. With reference to FIG. 6b, the bend in the peripheral flange 12a is at an angle approximately equal to the sloping side 26 of the anvil 20

and the roller bearings 110 are fully engaged with the cam 114. Thus, the prehemming of the peripheral flange 12a is complete. At this point, the engagement between the roller bearings 110 and the cam 114 prevent the prehemming surface
5 52 of the steel 28 from moving any further into the peripheral flange.

Initial
Further movement by the vertical press forces the steel 28 to pivot against the spring 42. The roller bearings 110 move along the cam 114 and the steel 28 pivots
10 from a first position to a second position. During the transition from the first position to the second position, the full-hemming surface 50 of the steel 28 engages and moves the peripheral flange 12a of the outer skin 12. The full-hemming surface 50 continues to bend the peripheral
15 flange 12a toward the inner panel 14 until the flange 12a is superimposed and pressed against the peripheral edge 14a of the inner panel 14. At this point the steel 28 is in its second operative position and the assembly is fully hemmed (FIG. 6c). As in a previous embodiment, the
20 vertical press may be reversed to remove the steel 28 from the hemmed assembly 10 and the hemmed assembly 10 may be removed.

The invention has been described with reference to the preferred embodiments. Obviously, modifications and
25 alterations will occur to others upon reading and understanding the preceding detailed description. It is intended that the invention be construed as including all such modifications and alterations insofar as they come within the scope of the appended claims or the equivalents
30 thereof.